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ABSTRACT

This booklet is designed to aid small manufacturing companies in ascertaining the meaning of going metric for their unique circumstances and to guide them in making a smooth conversion to the metric system. First is a brief discussion of what the law says about metrics and what the metric system is. Then what is involved in going metric is discussed in detail in terms of three major stages: (1) a rough analysis to determine whether it is worth looking at the question in greater detail; (2) conversion planning, in which estimates in the first stage are refined and specific decisions on how to proceed with conversion are made; and (3) actual conversion, in which the companies begin actually using metrics and checking their results. A list of other sources of information is provided. (MNS)

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GOING METRIC
Is it for you?

A Planning Model for
Small Manufacturing Companies

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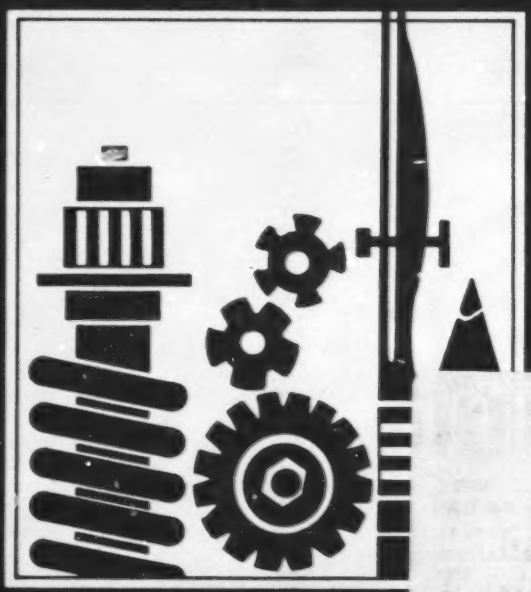

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GOING METRIC

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A Planning Model for
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Introduction

If you're reading this booklet, you're probably already thinking about "going metric" with some of your products or services. Small businesses have many reasons for considering such a change. For some, it is a good move; for others, there may be no real advantages.

This booklet is not intended to persuade you to go one way or the other. Its purpose is to help you find out what is best for your unique circumstances and, if you decide that you do want to go metric, to guide you to a smooth conversion.

The approach described in the following pages is a general one, designed for almost any kind of a small manufacturing company. It will help you to recognize the many factors you should consider before deciding to "go metric" – the technical term is "metricate" – and will point out possible pitfalls if you do move in that direction. Because it is general, some of the specific points raised may not apply to your business.

Also, some important points are discussed in considerable detail, while other points are only touched on so you won't miss them if you are doing a more extensive analysis. If you are going to that depth, you may want to review the list of other sources of information on most of the subjects in this booklet. Some handy conversion factors are also included for your convenience at the back of the booklet.

What The Law Says About Metrics

Many people have the impression that a government decision has been made to adopt the metric system of weights and measures in the United States.

The fact is that the Metric Conversion Act does not require anyone in the United States to use the metric system. Nor is there an official policy to replace the customary system – often known as the "English" system – with the metric system for all uses.

The Metric Conversion Act, which was passed by the Congress on December 23, 1975, says only that:

> "... the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system."

As this Act and its legislative history make clear, the national policy is not to prefer one system over the other but to provide for either to be used on the basis of the voluntary actions of those affected. This policy of choice of converting or not converting has been U.S. policy since 1866 when use of the metric system in the United States was first authorized.

The United States Metric Board, created under the Act, neither advocates nor discourages metrication. Rather, its responsibility is to devise and carry out a broad program of planning, coordination, and public education, consistent with other national policy and interests, to help organizations that do choose to convert to metrics. The Board's 17 members were nominated by the President and confirmed by the Senate in 1978. During the three years after it became operational, the Board conducted an active program in support of its Congressional mandate. In 1982, however, the Board phased out its activities because of Federal budgetary reductions.

What Is Metric?

In most countries of the world, the metric system – in the form of the International System (SI: Systeme International d'Unites) – is becoming the standard. Developed in France at the time of the French Revolution, the metric system was based primarily on the meter, a length defined as a small fraction of the earth's circumference. Since then the system has been refined and updated in many ways. Currently, it uses seven basic units.

Length: ..... **Meter**
Mass:[1] ..... **Kilogram**
Time: ..... **Second**
Electric Current: ..... **Ampere**
Temperature: ..... **Degree Kelvin**[2]
Luminous Intensity: ..... **Candela**
Amount of Substance: ..... **Mole**[3]

Standard prefixes, such as "centi-" (as in "centimeter" – 1/100 of a meter) are added to give names for quantities of a particular unit that differ by multiples of 10. Other examples are the "kilometer" (1,000 meters) and the "millimeter" (1/1000 of a meter).

Our customary system of units is related more closely to human experience and human anatomy, from which it was derived. The "foot" is roughly the length of a human foot; the "yard" is approximately the distance between an adult's nose and the fingertips at the end of of an outstretched arm; and the "mile" is about 2,000 paces. The temperatures of 0° and 100° Fahrenheit are based roughly on the coldest and hottest temperatures common in northern Europe, where these units were first established.

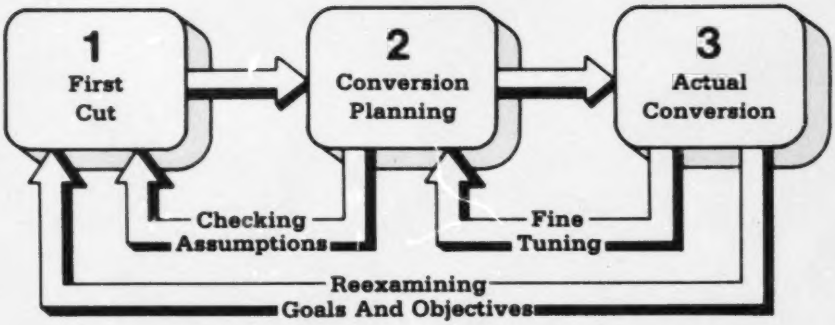
The metric system has been used for more than a century as the measurement "language" of the sciences. Scientists are concerned with changes in states of matter more often than with human anatomy and human experience. In designing temperature scales, for example, they set 0° and 100° Celsius as the temperatures at which water freezes and boils.

An intrinisic advantage of the metric system is its decimal nature. This greatly simplifies converting, for example, larger to smaller measuring units. To calculate the number of centimeters in 4.26 kilometers, multiply by 1,000 (move the decimal point three places to the right) to obtain 4,260 meters, then multiply by 100 (move the decimal point two

[1]Commonly called "weight."

[2]Commonly translated into the degree celsius, formerly called the degree centigrade.

[3]Useful in chemistry where the number of molecules is more important than the mass.



The Metric Conversion Process

more places to the right) to get the answer: 426,000 centimeters. By comparison, finding the number of inches in 4.26 miles requires multiplication first by 5,280 to convert to feet, then by 12 to get the answer: 269,914 inches.

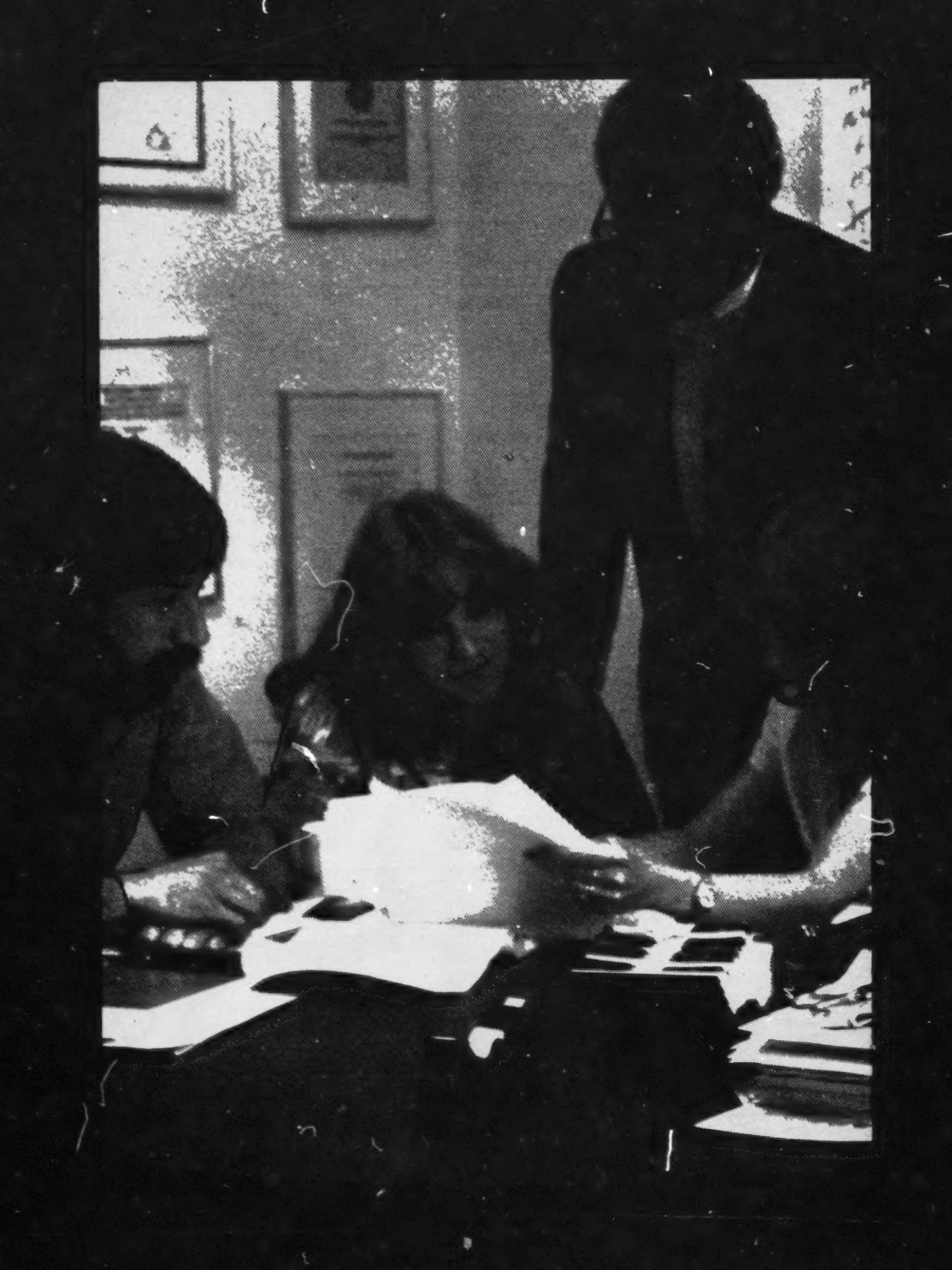
More complete definitions of metric units and detailed information on conversions between metric and customary units are provided at the back of this booklet.

What's Involved in Going Metric?

Going metric involves much more than simply learning and using the metric system. It includes such things as deciding which products to metricate and what sizes to use; manufacturing to metric dimensions; training personnel; obtaining metric supplies; modifying regulations, ordinances, and codes to accommodate the metric system; informing customers about metric products; and remaining competitive in the marketplace.

If you are considering going metric, it's wise to use a systematic approach to making and carrying out the decision. We suggest three major stages.

In the initial stage – called the **First Cut** in this booklet – you do a quick, rather rough analysis to determine whether it's worth looking at the question in greater detail. If you decide that the situation looks favorable for metrics, you then start **Conversion Planning;** in this stage, you refine the estimates used in the First Cut and make specific decisions on how you will convert. This leads to the third stage, **Actual Conversion,** in which you begin actually using metrics and checking your results. As you gain experience, you can "fine tune"; your plans and even take another look at your goals and objectives in going metric. You may find opportunities for further conversions, or possibly good reasons for changing back to customary measurements for some or all of your products. Even if you decide not to go metric now, stay in touch with the metric trends in your industry and reevaluate the situation periodically.



The First Cut

To metricate or not to metricate is a serious question. . .

Owners and managers of small businesses usually can determine within just a few hours whether it's worthwhile to consider "going metric" seriously. This is what we mean by "taking a first cut." Although the time required may stretch out to a couple of days if you need to spend some time finding out what's going on in your industry, the important thing to remember at this stage is not to get bogged down in details. In all the steps talked about here, rough estimates are good enough; there will be plenty of time to refine your figures later if you do decide to metricate.

The reason for taking a first cut is that, more often than not, small businesses find that the arguments for either going metric or not going metric are quite powerful. If your most important customers are converting their own production to metric, for example, you may have little choice but to follow their lead if you want to keep their business. If it's clear that you would have to do a lot of education to get your customers to prefer metric products, on the other hand, metrication is probably not a good idea for you. Relatively few small businesses find themselves in a borderline situation.

In any case, however, its good to analyze the situation systematically – even if you do so quickly – rather than making a snap judgement. The next few paragraphs suggest how you might do this.

Among the first things to consider is what you expect to achieve – your overall goals and objectives – if you do go metric. Are you interested in entering new markets (possibly including foreign markets), finding new customers, or broadening your product line? Or, are you simply trying to keep your share of an existing market that is changing to metric units? Is the whole industry changing over, or is a major customer or supplier converting to metric products? These questions are part of doing a preliminary. . .

Market Analysis

The whole point of doing a market analysis is to satisfy yourself that there is a real market for the metric products you are thinking about, and that this market is large enough to justify the time and money that going metric may cost.

The place to start the analysis usually is by taking a hard look at what is going on in your existing markets. There may be early movement toward metrication in the industries you serve. The sooner you know about such trends, the more time you will have to consider their impact and to plan for what you want to do in your own business.

Many small businesses first think about metrication when one or more of

their important customers changes over to metric. A major industry that is shifting much of its operations to metric, like the automobile industry, has a significant influence on its suppliers and the small businesses that sell to these suppliers. If you are in this position, your major customers typically will be quite willing to discuss their metrication program with you and may be willing to help you to convert.

If a few of your customers convert to metric, this may signal the direction in which a larger group of customers, even an entire industry, will soon be moving. While considering a change to metric to accommodate these existing customers, therefore, you may want to explore the possibility of finding additional customers in their industry, particularly if you are one of the first suppliers to convert. Also, once you've converted your operations to produce a few metric products for your existing customers, you might be in a good position to sell them a new line of metric products.

Another early signal of trends toward metrication in your industry may be the activities of your own suppliers. If your suppliers are beginning to offer some metric products along with your customary products, it may pay to ask them what prompted the conversion and how well the new metric supplies are selling. Although your present customers may not be buying metric products, sudden metrication activities among your suppliers may be a clue to possible new markets where a demand for metric products is being satisfied by your competitors.

This suggests another source for information about your potential market for metric products – your competitors themselves. Are their advertisements, catalogs, or trade show exhibits featuring metric products? If you belong to a trade association, it can be another excellent source for a quick review of what is happening in your industry.

Finally, there are two additional marketing areas to consider if you are thinking about going metric – foreign markets and the U.S. Government. There may be special opportunities for your firm to do business in these two areas. Both may be potential purchasers of metric products, but each requires a great deal of specialized knowledge on procurement practices, standards, laws and regulations. While an extensive discussion of these two markets cannot be covered in this booklet, there are a few issues and facts you should be aware of in making your decision on metrication.

All of the major foreign trading partners of the United States are now using or are converting to the metric system for their domestic and international trade. The Council of the European Communities (i.e., the Common Market) has issued a directive obligating its member countries to standardize on

First Cut Check List

I. Market analysis

- ☐ Define goals and objectives
- ☐ Check existing market and customers
- ☐ Check suppliers trends
- ☐ Check competitors, their advertisements, catalogs, etc.
- ☐ Consider new markets, new products
- ☐ Identify types of product conversions most appropriate
- ☐ Project metric sales and gross profits

II. Cost analysis

- ☐ Revising documentation (drawings, labels, catalogs, specs.)
- ☐ Adding, replacing, modifying machinery, tooling, equipment, and hand tools
- ☐ Training employees in metrics
- ☐ Dual inventories purchasing, storing, handling
- ☐ Consider timing for cost savings
- ☐ Project total conversion costs

III. Preliminary conversion decision

- ☐ Compare incremental metric profits against costs
- ☐ Make preliminary decision

metric units by 1985. The United Kingdom, Canada, and Ireland, which previously used customary units, are shifting to metric units. Countries like Australia and New Zealand have already converted almost completely. Japan has been metric since 1966.

Some of these countries are requiring metrics for labeling and packaging of consumer goods, for the documentation of goods entering their borders, and for calibration of scales and other weighing and measuring instruments. While many countries do not prohibit the admission of goods labeled in nonmetric units, they frequently require that metric labels be affixed before the goods enter retail trade. You also should be aware that there are foreign regulations requiring both the production and packaging of goods in regular, whole-number metric sizes (e.g. 250 grams, 500 grams, 750 grams, 1 kilogram, etc.). This is particularly common in countries that formerly used customary units. Most foreign countries have national standards organizations that issue product engineering standards drawn to metric dimensions. Local building and safety codes, public bids, and private industrial projects frequently call for products manufactured according to such specifications. Thus, there are both legal admissibility and commercial acceptability issues to be evaluated in considering foreign markets.

As for selling metric products to the U.S. Government, you should know that the Small Business Administration has a program for encouraging Federal procurements from small businesses. U.S. Government procurement of supplies and equipment from small businesses is significant. In fiscal year 1980, for example, such purchases totaled over $11 billion. Of this amount, over $9 billion was purchased by the Department of Defense, and another $1 billion by the Department of Agriculture.

Although specific numbers are not available on how much of this business was for metric products, there has been increasing use of metric products within the U.S. Government, particularly by the Department of Defense. Since 1976, DOD has had formal policy directives that require metric units to be considered in all new designs and acquisitions. On a broader scale, the Federal Interagency Committee on Metric Policy, chartered by the U.S. Metric Board, has issued two documents which provide guidance on metrication to Federal agencies: "Metric Conversion Policy for Federal Agencies" and "Federal Metric Information Referral Directory." Most agencies involved in purchasing supplies and equipment have Committee representatives who can provide information on the current status of metric conversion in their agencies.

In exploring opportunities to market metric products, you should be aware that metric products can be of three varieties:

- **Hard Metric Products** - Products that are produced to metric dimensions or packaged in containers sized in metric units, and are labeled in metric units
- **Soft Metric Products** - Products that are still produced to customary dimensions or packaged in containers of customary sizes, but are labeled in metric units or, more commonly, in both metric and customary units
- **Hybrid Metric Products** - Products comprised of both metric and non-metric parts or components

The decision as to which of these is best for you will depend on your customer needs, customs in your industry, the type of product, alternative manufacturing or packaging costs and possibly other factors.

At this point, you should have a good concept as to which of your existing products are candidates for conversion and what kind of conversion is appropriate (hard, soft, or hybrid), and a rough estimate of how sales volume might increase by going metric. In projecting the increase in sales volume (known as "incremental sales"), remember that some metric product sales may be at the expense of sales of customary products.

The most useful way to complete the market analysis is to determine how much gross profit you can expect from the incremental sales you have just projected. This is calculated, of course, by subtracting the estimated cost of manufacturing the number of additional units you expect to sell (direct materials, direct labor, and factory burden) from the selling price of those units. The result is known as "incremental gross profit." Save this figure for use later in the analysis.

There are, of course, conversion costs to be considered, as well. These are looked at in the first cut. . .

Cost Analysis

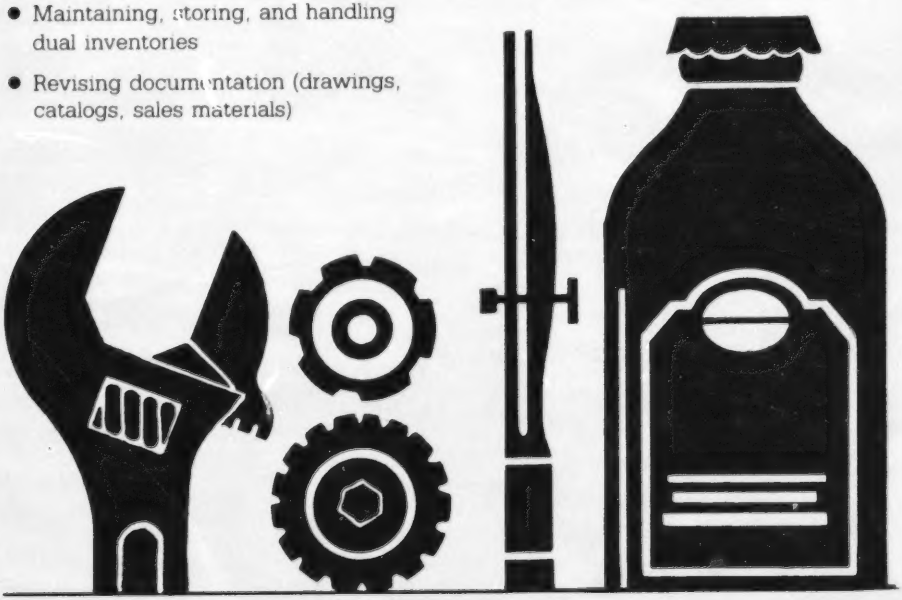
In this part of your initial analysis, you will be developing rough estimates of the costs of converting to the metric system and considering whether there will be any significant non-cost disadvantages. Most small businesses that have converted to the metric system report that their conversion costs have been relatively insignificant, but you should not assume that this will apply to your business until you have thought through your situation carefully. Some of the cost items to consider are those of:

- Adding, replacing, or modifying machinery, tools, and equipment
- Adding, replacing, or modifying inspection instruments and equipment
- Training employees in the metric system
- Maintaining, storing, and handling dual inventories
- Revising documentation (drawings, catalogs, sales materials)

Here again, as with the marketing analysis, precise figures are not necessary for this first cut. Although it would be advantageous to have the most accurate information available, a great deal of time and effort should not be spent in developing detailed cost estimates.

At first look, firms that have gone through the conversion process expected to incur considerable costs for these items. However, after carefully looking at how the conversions could be economically made, they found that the expected higher costs generally disappeared, or were minimal.

The timing of a conversion program – both the starting time and the duration of the transitional period – can have a significant impact on costs. If you can phase in the conversion gradually, it may be possible to convert machinery and equipment only when it would be

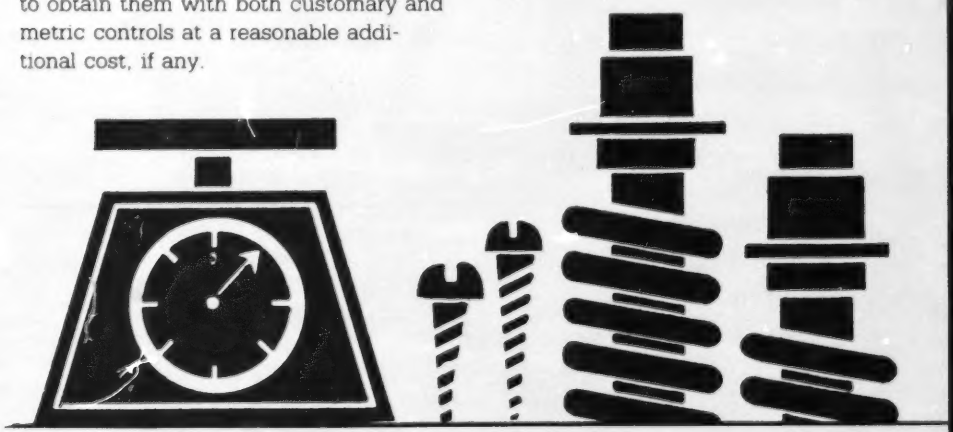


replaced normally. Similarly, it may be possible to avoid the obsolescence of costly inventories of products sized in customary units.

Small businesses have found that in most cases major machinery and equipment investments are not required to produce and inspect metric products. It is seldom necessary to replace or even greatly modify customary manufacturing machinery to produce metric products. With dual labeling and conversion charts, workers have been able to produce metric products with little, if any, special training. Metric products usually can be produced on the same machinery used to produce customary products if the dimensions on drawings and specifications are converted from metric to customary units before they are sent to the factory floor. In some cases, where scales and volume measuring devices are used, modifications can be made by affixing a metric dial or indicator; sometimes only new weights or beams, available from scale manufacturers, are needed. When buying new machine tools and equipment, it is often possible to obtain them with both customary and metric controls at a reasonable additional cost, if any.

In some industries, tools are provided to employees by the employer, so the cost of metric tools must be added to the employer's cost of conversion. In other industries, employees provide their own tools. In these cases, it is necessary to consider whether requiring employees to buy new metric tools will create a labor relations problem. If so, can this be offset by giving the employees a one-time tool allowance? Or, can special arrangements be made with a supplier for providing the tools at favorable prices to your employees?.

With respect to personnel training, you will need to visualize your real training needs and what these might mean with respect to a training program. Who will need training – all of your employees, or only one or two who will convert dimensions on drawings from customary to metric? Costs can be reduced by training only those who need to know when they need to know. If all employees will have to be trained in the metric system, how extensive must this training be? Will you use on-the-job training,



in-house training classes, or outside resources? How much lead time will you need to design and prepare your training material, if you do it in-house? When you have thought through questions such as these, you should be able to develop a preliminary estimate of your training costs.

In developing this estimate, do not forget that additional costs may sometimes be incurred because productivity may decrease and scrap increase temporarily, while employees acquaint themselves with new terminology and product sizes. On the other hand, some firms have experienced a decrease in scrap after converting their products to metric. This occurred because the metric dimensions of their converted products happened to more closely match the standard size stock material from which the products were manufactured.

Manufacturers who produce only to order do not have to worry about dual inventories, but this may represent a significant cost to manufacturers who produce for inventory. When such manufacturers convert to metric, they typically continue to produce in customary dimensions also. This creates the need to maintain dual inventories. Because minimum stocks must be maintained in both inventories, the dual inventories often are more than twice as large as the previous single inventory. You will need to estimate how much your inventories are likely to increase, then calculate the costs of financing, storing, and handling the added stocks.

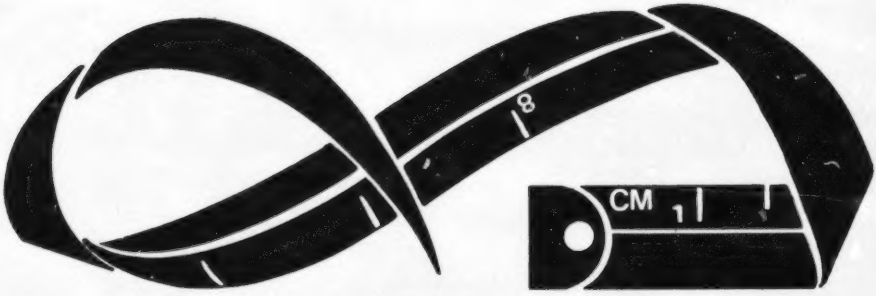
Estimating documentation costs usually is relatively easy. The largest cost in this area may be for printing new and possibly expanded catalogs. Again, however, this cost often can be minimized by timing your conversion to the time when new catalogs normally would be published anyway.

Depending on your circumstances, there may be new costs other than the ones discussed above. If your primary reason for going metric is to increase export sales, for example, you may have to plan on sharply higher shipping costs. If you plan to sell in countries in which English is not the common language, you may incur significant costs in having your catalogs and product literature translated into the languages used in those countries.

When you are reasonably sure that you have thought about all the areas in which you are likely to incur significant new costs, add these costs to arrive at your first cut at total conversion cost. This figure, together with the figure you developed earlier for expected increase in sales, is what you will need to make. . .

The Preliminary Conversion Decision

In most cases, a simple comparison of the incremental gross profit you projected earlier against estimated conversion costs is all that is needed to decide whether to carry your analysis further.



One way of expressing this comparison is in terms of a gross "payout" period: If you project incremental gross profits of $20,000 a year and your estimated conversion costs are $40,000, your gross payout period is two years ($40,000 divided by $20,000). For a more precise calculation of payout period, you need to add the cost of interest on your conversion investment cost, which will increase the payout period. Owners of small businesses typically decide not to go ahead with new programs when they see payout periods of longer than two or, possibly, three years.

Although this is the most common way of deciding to convert or not to convert, there could be other, more important criteria in your particular case. Your original objective for converting might have been, for example, to keep a particularly important customer who needs just a few metric items but also is able to give you other business that is highly profitable. You might consider it worthwhile realizing a less than normal profit – maybe even a loss – on these few metric products to accommodate this customer.

Regardless of the criteria you use, the end result of the first cut is a decision either to drop the idea of metricating, at least for now, or to take a much closer and more careful look at metrication. If you find that estimated conversion costs are considerably larger than projected incremental gross profits, or that other considerations of particular importance to you are predominately negative, this is the time to make your decision against metricating. It may not be right for your particular situation at this time. It makes no sense to spend any more time or incur additional costs to do more detailed planning.

If you do decide against metrication, it is still wise to continue to keep an eye on trends in your industry, conditions may become more favorable in the future, and it's better to recognize a change in the situation too early rather than too late.

If, on the other hand, your analysis results are positive, it is time to proceed to the detailed planning necessary to start the actual conversion. While you are doing this, you will be automatically refining the estimates and projections you made for the first cut. If any of them change substantially, the decision to go ahead can be reexamined at any point.

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Conversion Planning

To get started on conversion planning, most small businesses find that things work best if one person is appointed to coordinate the metrication process. As a small business owner, you may decide to do this yourself, or you may appoint a senior member of your staff. In some cases, you may feel the need to set up a committee to work with this individual and with members representing the various parts of your business that will be affected. If your metrication program will entail substantial costs and a large part of your product lines, it might even be worthwhile considering engagement of an outside advisor who is experienced in metrication and perhaps has a different or broader perspective on what is occurring in your industry.

The conversion planning process usually involves development of plans in four major areas – marketing, production and inventory control, personnel, and information systems. Some suggestions for each of these areas are discussed in the next few pages. The Work Planning Checklist shown on page 19 may be helpful to you in planning your conversion to the metric system.

The Marketing Plan

To begin the preparation of a work plan, you can use the results of the preliminary market analysis to develop two separate forecasts: a forecast of metric product sales over the short-term future, typically a year, and a long-term forecast of future metric product sales, often covering the next five years. The short-term forecast should be developed in considerable detail, with as much accuracy as you can achieve; seasonal variations in sales and prices, if any, should be taken into account. The long-term forecast is more general, often indicating only projected growth rates by product or product line.

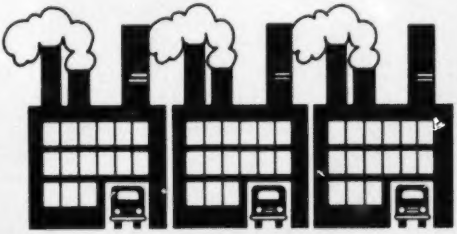
Concentrating first on the short-term sales forecast will provide the information needed by all parts of the company to prepare and plan for producing metric products. The short-term sales forecast must identify the specific products and the type of metric conversion (hard, soft, hybrid) for each. The production and quality control departments need this information to know whether they should plan for actual manufacturing changes, just "paperwork" changes, or both. The short-term sales forecast should show expected sales by month as a basis for planning production volumes and inventory levels. Impact on the demand for service and repairs, and possibly additional income from these sources, should be taken into account.

You will want to notify current customers, and prospective new customers as well, of the availability of your new metric product line. This will require planning (including scheduling) of sales

literature, catalogs, letters, and other such advertising material. Pricing changes (determined in the cost planning process, described later) will also need to be posted.

Long term marketing projections provide the basis for future marketing planning. If you have decided to convert some of your products to metric dimensions or packaging, you should consider pursuing the marketplace aggressively for both the short-term products you have already identified and also new metric products. You may wish to consider the possibilities of additional income from sales of related products, rental or leasing, and perhaps even licensing other companies to manufacture or sell metric products you have patented.

As part of your marketing plan, you may want to designate an individual to be responsible for metric marketing to ensure that new sales possibilities are not overlooked. Although you may not previously have been involved in overseas sales, for instance, metric production capability does open up the possibility of an expanded market for you. There are, of course, many factors to consider before deciding to enter foreign markets. Similarly, in developing your marketing plan, you may want to consider the potential for metric product sales to the U.S. Government. One source of marketing information is the "Commerce Business Daily," a listing of U.S. Government procurement invitations to bid, contract and subcontract awards, sales of surplus property, and foreign business opportunities. If you would like to learn more about this area, you can find helpful information in some of the publications listed at the end of this booklet.



The Production And Inventory Plans

Once the marketing planning is well along, you can begin planning the changes you will need to make in your production and inventory control departments. Using the short-term sales forecast for metric products, the production manager, product designers, purchasing agent, and sales manager[4] can begin to plan production, procurement, and documentation changes. In some cases, metric conversion will consist simply of translating the metric measurements into customary units, product by product, and providing the translated documentation to production or procurement. In other cases, the need to produce or buy some fasteners, scales, or containers, in metric standard sizes will necessitate new or modified machine tools, parts, or suppliers. For each product to be metricated, necessary changes in drawings, specifications, and labels should be identified and the time and

[4] We recognize that many small businesses will not have separate people in each of these positions. We are referring here to the person who performs these functions – possibly even the owner himself – not necessarily the people with these titles.

Work Planning Check List

I. Marketing planning

- ☐ Specifying new metric products (immediate and long term) and delivery schedules
- ☐ New markets/customers; existing customers; overseas markets
- ☐ Sales literature; catalogs
- ☐ Customer notification
- ☐ Plan continuing metric market research

II. Production/Procurement/Inspection Planning

- ☐ Engineering/design changes
- ☐ Documentation/labeling changes, drawings, specs, standards
- ☐ Tooling/equipment modifications
- ☐ New tooling/equipment/hand tools
- ☐ Supply sources – identify and notify
- ☐ Purchasing/procurement specifications
- ☐ Set up dual inventory facilities/procedures for purchasing, storage, and distribution
- ☐ Schedule metric production lead times for purchases, tooling, etc.

III. Personnel Planning

- ☐ Employee notifications of program
- ☐ Administrative employee training
- ☐ Marketing employee training
- ☐ Production/inspection/engineering/procurement employee training
- ☐ Training materials/courses/external or internal
- ☐ Training facilties/tools
- ☐ Pilot testing – administration and production
- ☐ Scheduling and training/testing

IV. Information Systems Planning

- ☐ Administrative reporting/accounting systems
- ☐ Communications forms (task orders, work orders, requisitions, etc.)
- ☐ Accounting reports
- ☐ Inventory reports
- ☐ Computer information program changes
- ☐ Scheduling procedural and administrative reporting changes

materials needed to make the changes should be estimated.

The production and procurement staff should work with product designers to ensure that necessary design changes take into account the most efficient ways of making changes in manufacturing processes. The production staff can review the planned drawing and specification changes and determine the need for modified or new tooling and special hand tools. They may be aware of more effective ways to make the changes, based on their operating experience. The procurement staff can determine the need for new metric part suppliers. Some work will need to be started at this stage in contacting suppliers for both parts and tooling in order to estimate the lead times to be expected for these items. Estimates of production time can then be made, considering these lead times and manufacturing time required for the product conversions.

Using the sales forecasts and production or procurement schedules, the need for dual inventories can be determined. Facilities may need to be planned for storing additional inventories, and new procedures may need to be developed for determining inventory levels and for storing, handling, and distributing the dual inventories. As noted earlier, most companies continue to produce both metric and customary products, thus requiring such dual inventories on a continuing basis.

The Personnel Plan

Successful conversion to metrics requires people who understand why the change is being made, support the idea, and are ready to do what is necessary in their own jobs to make it work. Thorough personnel planning is the key, especially if you expect any resistance or labor relations problems as the conversion takes place.

Making everyone aware of the conversion program is the first step. You can do this by preparing an announcement briefly explaining why metrication is important to the future of your company and summarizing the primary steps involved. In addition, you can hold an orientation meeting in which you describe the program in greater detail, assign individual responsibilities, and talk about how each individual or group will be affected. Employees should be encouraged to talk freely about their fears or dislikes of the metrication process, if they have any, so that these can be met head on. At this stage, detailed planning for the conversion will still be in the early stages; the orientation meeting is a good time to start bringing more people into the planning process – not only because they can make a real contribution, but also so they will feel some "ownership" of the conversion.

Depending on how complicated your product lines and company operations are, you may need to tailor separate training programs for administrative, marketing, and engineering/production/inspection/procurement staffs. Some basic orientation materials on the metric system can be used by all of these groups, but the focus and depth of training will vary:

- Administrative personnel will be most concerned with management reports

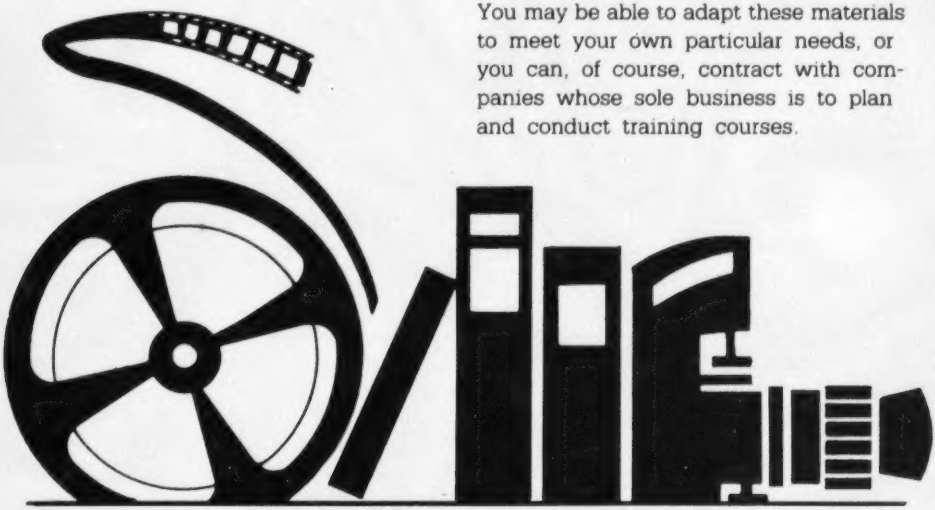
on status of procurements, production, costs, and sales. Simple conversions and comparisons of customary and metric units will be important to them.

- The marketing staff may require somewhat more extensive training so that they are competent and comfortable in discussing product sizes, performance, and other characteristics in metric terms.
- Engineering, production, inspection, and procurement personnel may require the most extensive training, although some of them may already be quite competent in working with the metric system.

These differences in training requirements should be considered when preparing detailed training plans. In the smallest businesses, it often is both desirable and possible to consider the training needs of each employee, one by one.

A specific decision must be made at this time on whether you and your staff will do the training or whether you will use outside resources. In making this decision, you may need to consider such factors as how well the metric system is understood by the people in your company who might do the training, their ability to train others, and their availability to do the training in addition to their present duties

If you decide to train with in-house resources, training courses must be planned, and training materials and teaching aids must be prepared or purchased. If you decide to look outside, you will find that numerous organizations throughout the country have developed a wealth of metric training materials. These materials are available in a variety of forms such as printed booklets, worksheets, slides, films, and videotapes. They can be obtained from private industry, commercial training firms, technical or community colleges, high schools, unions, trade associations and others. You may be able to adapt these materials to meet your own particular needs, or you can, of course, contract with companies whose sole business is to plan and conduct training courses.



In addition to classroom training, you may want to consider the need for hands-on training with special hand tools, machine tools, and inspection equipment. Although it should not be necessary in most cases, you may want to plan a limited pilot test of the conversion to metrics in both the procurement/production/inspection functions and the administrative functions. The pilot test will show you whether additional or different training is necessary for any part of the organization.

When you have made all these decisions, your personnel plans can be put in final form, complete with a schedule laying out what action must be taken, who will be responsible for and affected by each action, when it will be started, and how long it will take. When this is completed, you can turn to. . .

The Information Systems Plan

The next area to be considered in your work planning is your information systems. Necessary procedural changes will have been identified previously by various groups in the company as they plan to modify their activities to accommodate the metric conversion. You now will need to consider how the information systems of the company will have to be changed to support these procedural changes.

This can start with a survey of all internal forms to identify the ones requiring changes due to the change to metric units. Dual entries may be required on some forms for both customary and metric units. Report formats should be reviewed in the same way to determine whether they, too, need to be changed. It may be desirable to allow for parallel reporting in metric and customary units for a limited trial period.

Another significant planning element in this area focuses on program changes that may be required in any computer programs you now use. Estimates will be needed of the time and cost of necessary reprogramming. As with the other areas of the work planning, the information systems changes must be scheduled, showing projected start dates for making the changes and the estimated time to complete each change.

With the information from the four planning areas described above, you now are ready to make...

The Final Conversion Decision

As you work through the areas described above – carrying each only to the degree of detail appropriate for your own particular situation – you will have completed a comprehensive, detailed work plan for your metric conversion. As an important by-product, you will have refined your projections of metric product sales, developed more accurate estimates of the costs of conversion, and examined more closely some of the intangible advantages and disadvantages of metrication. If you discover that any of these considerations are less favorable

than you thought during the first cut, you may want to take another look at your decision to go ahead.

Before you make a final decision to metricate, however, there are also some additional cost factors to look at, and you may wish to complete a somewhat more detailed analysis of the probable financial impact of metrication on your company.

Two additional cost factors are of particular importance and should not be overlooked. First, consider whether you will need to borrow money to cover the costs of conversion. If so, how much, and for how long? In answering these questions, it is useful to develop a "cash flow" analysis, using the figures you developed earlier to project how the conversion to metrics will affect the flow of cash into and out from your company. When you have determined your borrowing needs, if any, consider how much these loans will cost in the form of interest. This cost should be added to the conversion costs you estimated earlier.

In looking at your conversion costs, you should also consider the tax implications of your metrication plan:

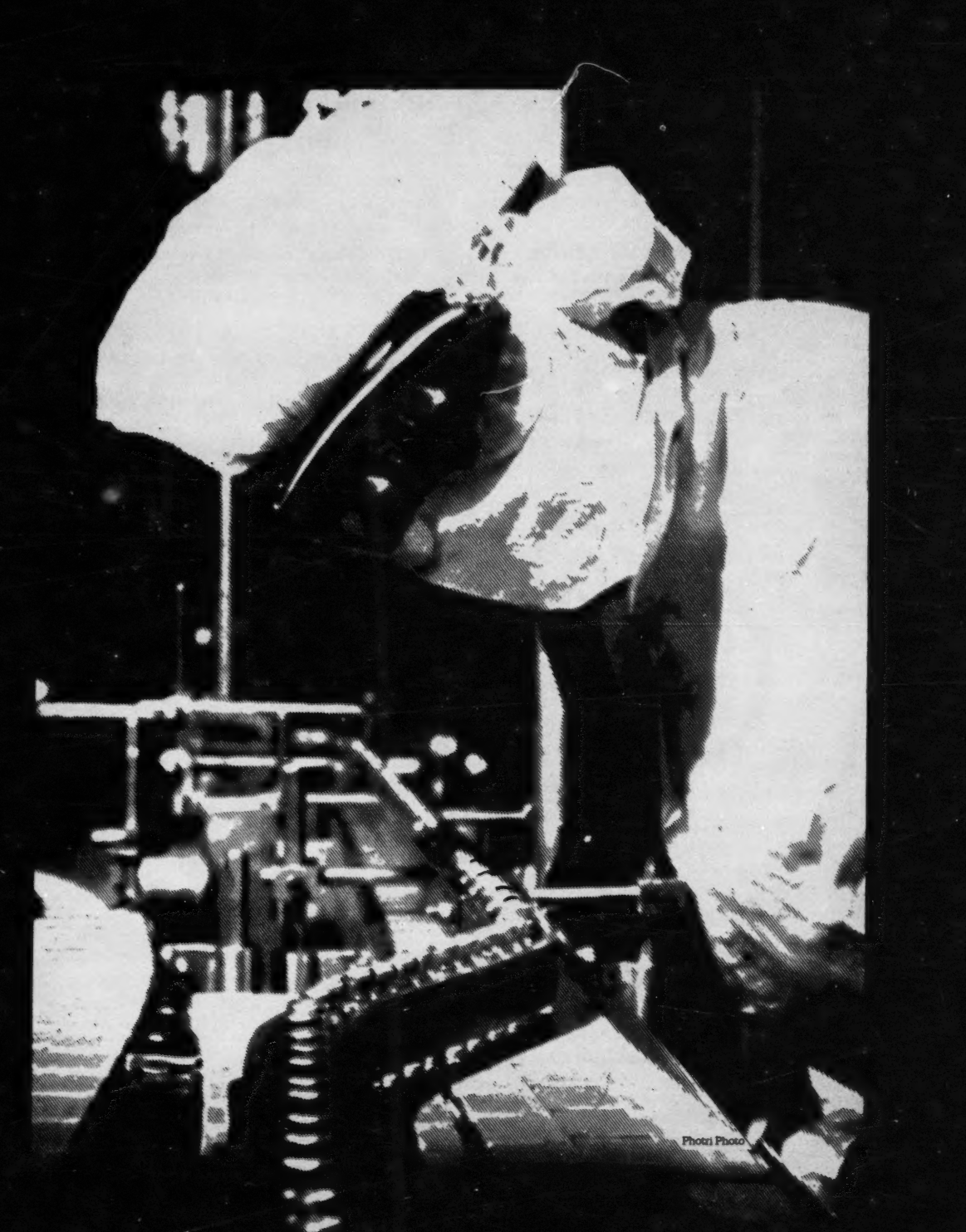
- Under the **accelerated cost recovery provisions** of current Federal income tax laws, qualifying machinery and equipment you buy for the metric conversion are depreciated over periods of three or five years.
- **Investment credit** is available for companies and workers who acquire qualifying new machinery, equipment, and tools.

These provisions relate, of course, to the Federal income taxes your company pays. Similar credits may or may not be available under the state income tax laws to which your company is subject. If you qualify for any such credits, they may be used to reduce the costs of conversion you estimated earlier.

When you have determined whether any of these additional cost considerations apply, you are ready to finish your financial analysis. Using your profit and loss statements and balance sheets from prior years, the first step in this analysis might be to forecast what these statements will look like for the current and next year, as your conversion program is carried out. These forecasts are known as "pro forma" financial statements.

If the arguments for or against metrication are quite clear cut for your company, you may wish to stop the analysis at this point or proceed with the actual conversion. If you are in a more borderline situation, however, you may want to do an even more detailed "breakeven analysis" analysis. This and other financial analysis techniques, such as "return on investment" cost for metric conversion, are often useful in such situations, but they are too complicated for explanation here. Some of the references listed at the end of this booklet will show you how to use them. You also may want to ask for help from your accountant or other outside advisor.

If your final conversion decision is still positive, you now are ready to go on to the actual conversion.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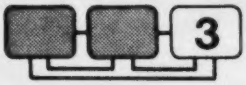
Actual Conversion



As you move into the actual conversion, your primary attention will be focused on beginning to produce and sell metric products according to the plans you developed during the conversion planning stage.

A useful way to start the actual conversion is to convene a "kick-off" meeting, similar to the one held at the start of the conversion planning stage. In this meeting, you can reconfirm your commitment to the metric conversion. Employee motivation and support can be enhanced by reviewing the importance of the conversion to the future of the company and thus to the job security of each employee, and by explaining again what conversion will mean in each employee's job activities. Depending on the size of your company, you may want to schedule one meeting for all employees or separate meetings for each of the departments affected.

To ensure that everyone gets the same message, it is helpful to use visual aids, such as posters, flip charts, or slides showing the overall conversion plan and schedule. In addition to using them at the meeting, posting these visual aids about the conversion plan and other metric information on bulletin boards in various areas of the factory and offices encourages employees to start thinking in metric terms. Materials prepared for training employees in specific metric conversion activities, for example, may be useful also for general employee orientation.

In accordance with your conversion plans, you probably will find it most effective to designate one person in each major activity – usually a department head, manager or foreman – as the conversion task leader for that area. These task leaders should study carefully the conversion plans as they affect the activity for which they are individually responsible. They should make sure that these plans are followed closely, unless specific changes are approved by all the task leaders collectively.

As your company begins to make operational changes to metrics, it is critically important that you keep a continuous check on how closely implementation of the metric conversion is tracking your plans. Many companies find that this can be done most effectively by having frequent meetings (most often weekly) of the task leaders to review the prior week's experience in implementing the conversion.

These meetings will be most effective if a set of special reports is generated for the use of the task leaders. The contents of these reports should be tied closely to your conversion plans and therefore will vary somewhat from company to company. In general, however, you may find it useful to generate a set of reports covering specific operational areas.

In the **marketing** area, data would be useful on weekly sales statistics for both metric and non-metric products in each product line affected by the conversion to metrics, possibly including these statistics by product and product line:

- Sales in units and dollars
- Sales by customer and customer type, with separate tabulation of sales to new customers
- Foreign versus domestic sales.

In the **production** area, again by product and product line, and typically by production department or major operation, data could be requested on:

- Units produced per hour
- Units rejected at first inspection and reworked
- Units scrapped, with dollar value
- Percentage of units shipped or put into inventory on schedule
- Actual versus planned inventory levels and dollar values.

In the **personnel** area, information data on number of employees who have completed metric training and turnover rates could be reported.

In the **information systems** area, data could be collected on progress in changing administrative procedures, forms, and computer programs against the planned schedule for these changes.

When you review these progress reports with your task leaders at a regularly scheduled meeting, the result typically will be improved communications among everyone involved and a reduction in potential conflicts, errors, and misunderstandings. The need for face-to-face review meetings cannot be overstressed; without such meetings, progress reports too often receive only a cursory review. Through discussion and exchange of ideas at progress review meetings, the need for corrective action can be recognized at the earliest possible time, and the decision to take such action can be made and communicated to all affected task leaders.

Each time the review uncovers a discrepancy between what you expected to happen and what has actually happened, you should investigate the situation to determine whether the discrepancy was caused by a flaw in the conversion plans or by someone not following those plans closely enough. If the latter, you may need to take corrective action before the situation gets even further off track. If the problem is with your plans, however, this is a signal that you should go back to the conversion planning stage to "fine tune" those plans to fit reality more closely.

In addition to "fine tuning" of conversion plans and implementation activities, most companies find it useful to carry out a broader scale evaluation of the conversion experience at intervals of six months to a year after the conversion to metrics is initiated. The primary focus of this evaluation usually is on reexami-

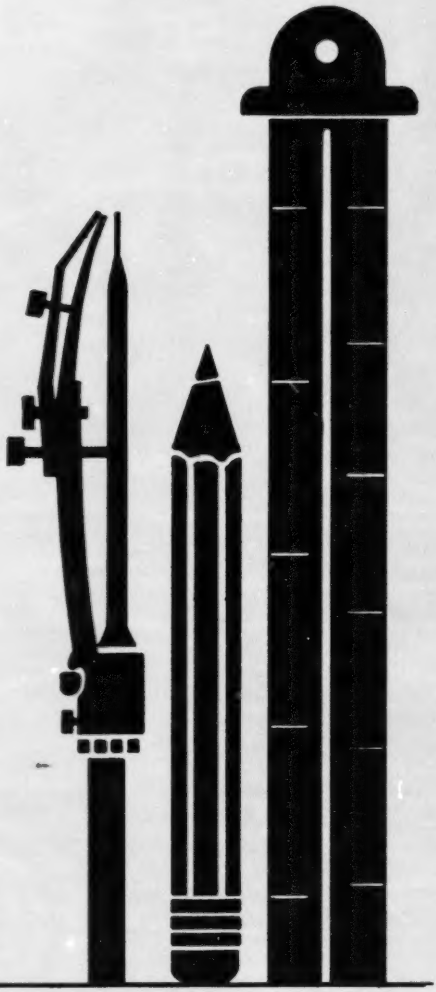
nation of the original metrication goals and objectives. Although you may have completed the conversion according to your work plan, taking a second look after you have produced and marketed metric products for six months or a year may reveal that your work plan may have overlooked some internal capabilities or limitations that have turned out to be particularly important in this situation.

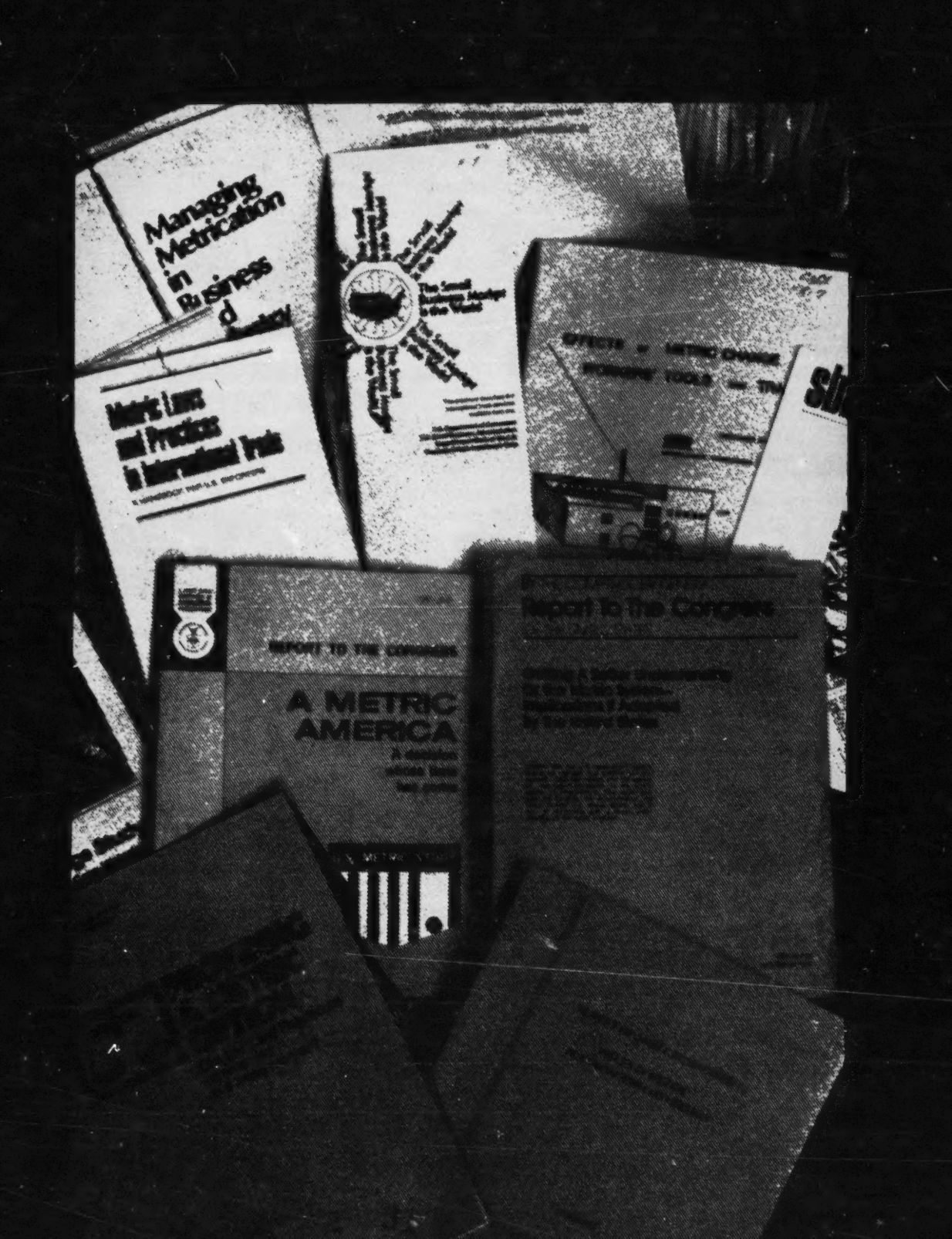
Also, external conditions may have changed to such an extent that your original goals and objectives may no longer be appropriate. For example, market demand for your metric products may have changed (either upward or downward), the split between domestic and foreign sales may have turned out to be quite different than what you anticipated, or you may have encountered unexpected difficulty in buying essential metric supplies.

On the other hand, your experience with metrics may have convinced you that the market potential is even better than expected, and the conversion process easier and less expensive; this might convince you that your metric conversion plans should be expanded significantly.

In this latter case, the evaluation lays the groundwork for repeating the entire process described in this booklet. Following the same pattern used in the first move toward metrics, the attractiveness of new metric products or new markets for existing metric products is examined in a first cut; if the results of the first cut are favorable, conversion planning is initiated; conversion planning leads to actual conversion, then to periodic "fine tuning" and reevaluation.

By repeating this cycle periodically, your company can be relatively confident that it has taken full advantage of its market opportunities with respect to metric products, and at the same time has avoided embarking on metric conversions with insufficient profit potential.




Managing Metrication in Business
Report to the Congress
A METRIC AMERICA

List of Other Sources

Organizational Sources

American National Metric Council
5410 Grosvenor Lane
Bethesda, Maryland 20814

American National Standards Institute
1430 Broadway
New York, New York 10018

American Society for Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103

Federal Interagency Committee on Metric Policy
Mr. Howard B. Ellsworth
Chairman, Metrication Operating Committee
OUSD (R&E) SS, Department of Defense
Room 2A318, The Pentagon
Washington, D.C. 20310

Metric Commission Canada
320 Queen Street
Ottawa K1A OH5 Canada

Office of Productivity, Technology, and Innovation
U.S. Department of Commerce
Room 48-72
14th & Constitution Avenue, N.W.
Washington, D.C. 20230

Small Business Administration
1441 L Street, N.W.
Washington, D.C. 20416

South African Bureau of Standards
Private Bag X191
Pretoria, South Africa

Superintendent of Documents
U.S. Printing Office
Washington, D.C. 20402

Technical Help to Exporters (THE) Program
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

U.S. Metric Association
10245 Andasol Avenue
Northridge, California 91325

Or, by writing your State Department of Commerce to determine if there is a Metric Board within your State.

Published Sources

I. Training Materials

Middlesex Research Center, Inc. **Effects of Metric Change on Workers' Tools and Training.** Washington, D.C.: Middlesex Research Center, Inc., (3413½ M Street, N.W., Washington, D.C. 20007), July 1981.

Presents the findings of a study conducted with the purpose of gaining an understanding of the effects of metric change on selected occupations. Focuses on metric change.

Boselovic, Len, ed. **SI Metric Training Guide.** Washington, D.C.: American National Metric Council, 1979.

Additional sources of training materials are available through the American National Metric Council and the sub-committees of the Council by writing: American National Metric Council, 5410 Grosvenor Lane, Bethesda, Maryland 20814.

Those interested in obtaining training materials can also write to the United States Metric Association, Sugarloaf Star Route, Boulder, Colorado 80302, or can contact their State's Teachers Association – in particular, the Math Teachers' Associations.

II. Cost Analysis

Goulet, Peter G. **Attacking Business Decision Problems With Breakeven Analysis.** Washington, D.C.: U.S. Small Business Administration, April 1980.

Illustrates ways in which breakeven analysis can be applied to sales, profit, cost, and selling price problems and how it can be used to help make sound decisions for employing idle plant capacity, planning advertising, granting credit, and expanding production.

III. Marketing Analysis

James, Robert W. **Decision Points In Developing New Products.** Washington, D.C.: U.S. Small Business Administration, 1976.

Traces the new product development process for manufacturing companies – the new product idea, concept, opportunity model, and marketing strategy and the necessity to analyze the marketplace itself, the competition, and the customer.

Lang, John B. **Finding A New Product For Your Company.** Washington, D.C.: U.S. Small Business Administration. Management Aids No. 216, April 1980.

Discusses a practical approach to the selection of a suitable new product that can be made and sold at a profit. In addition, suggests sources that can be helpful to finding such a product.

United States Small Business Administration. **Marketing Research Procedures.** Washington, D.C.: U.S. Government Printing Office, 1980.

Emphasizes the six steps of marketing research procedures – the means by which information about the various elements that make up buying and selling is obtained and evaluated. In addition, contains a bibliography of U.S. Government and nongovernment publications for those who plan to do their own marketing research, those who need to evaluate market research being performed for their firms, and those who wish to learn more about the techniques of research being used in various marketing areas.

IV. Metrication – General Issues for Small Businesses

Fontaine, R.E. **Metrication – How One Small Company Did It.** Philadelphia, Pennsylvania: American Society For Testing and Materials, 1975.

Describes one company that converted its design and manufacturing operations to the metric system as the result of pressure from an increasing foreign market.

Foote, Mary and Annan, Sampson O. **Survey of Small Businesses: Issues in Metric Planning and Conversion.** Rockville, Maryland: DAMANS and Associates, Inc. (1370 Piccard Drive, Rockville, Maryland), December 1980.

Primary purpose of this study was to determine the scope and nature of the benefits, problems, and issues confronting small businesses in their voluntary conversion to the metric system.

Hitchcock, Henry H. and Coates, J.F. **The Search for Small Businesses with Investments In Metric Production.** Washington, D.C.: J.F. Coates, Inc. (3738 Kanawha Street, N.W., Washington, D.C. 20014), June 1981.

Study of a variety of suppliers and customers with a concentration on small businesses that have made substantial investments in converting to metric. Focuses on the costs, benefits, expectations, problems, opportunities, and outcomes of conversion. Reports on where the nation stands as a result of past and current policies.

Landvater, John. **What About the Little Guy?** Metric Bulletin, April 1977.

Presents the key to cost-efficient metrication as the development of simple realistic plans, including policies and benchmarks.

Metric Commission Canada. **A Metric Handbook for Small Business.** Ottawa, Canada, 1979.

Designed as a guide to assist businesses with plans to convert to the metric system. Provides employees with appropriate and timely information and training during the transition period and helps avoid unnecessary costs during the conversion process.

Metrication Board. **Going Metric In the Small Firm – A Practical Guide for Management.** London, England, 1975.

Provides a ten-point checklist for planning an efficient and economic metric change. Provides suggestions for planning a changeover so that the period of dual stocking is shortened.

Motley, John, G. III. **Metrication: Problems and Opportunities – Small Business and Metric Conversion.** Washington, D.C.: American National Metric Council, 1974.

Examines the role of U.S. small business in the metric conversion process and determines the attitude of the American small business community toward metric conversion and the potential impact of conversion.

U.S. Metric Board. **Metric Issues for Small Business – Executive Summary.** Arlington, Virginia, August 1981.

Presents the findings of a survey conducted by the U.S. Metric Board of five categories of firms – construction, manufacturing, retail trade, transportation, and wholesale trade. This study is part of a continuing effort of the Metric Board to report on the status of the use of metric measurements and identify the benefits from and problems with converting from customary to metric units.

V. Metrication – General Issues

American National Metric Council. **Managing Metrication In Business and Industry.** New York: Marcel Dekker, Inc., 1976.

Written for managers of all kinds of operations to assist organizations in meeting the planning and management challenges of metric conversion. Presents a case-study approach to metrication management, illustrating the common questions and problems.

Applied Concepts Corporation. **A Study of Metric Conversion of Distilled Spirits Containers: A Policy and Planning Evaluation–Comprehensive Report on the Conversion Process (Task 1).** Reston, Virginia: Applied Concepts Corporation (P.O. Box 2760, Reston VA 22090), August, 1981.

Assesses USMB's planning guidelines in the light of lessons learned in a conversion that has recently occurred – the conversion of containers for distilled spirits beverages. Establishes the historical baseline regarding events that occurred, the reasons for these events, their impacts, and the lessons learned in this conversion that may be meaningful for other industries.

Applied Concepts Corporation. **A Study of Metric Conversion of Distilled Spirits Containers: A Policy and Planning Evaluation–Final Report on Findings and Lessons Learned.** Reston, Virginia: Applied Concepts Corporation (P.O. Box 2760, Reston, VA. 22090), October, 1981.

Summarizes the results of the entire study of metric conversion of distilled spirits containers, which entailed conducting a detailed case study of the distilled spirits conversion and USMB's possible role in it, assessing the completeness and clarity of USMB's planning guidelines, conducting a survey of consumer awareness of and attitudes toward the conversion, and analyzing the implications of the findings from all of the above for USMB policy.

Applied Concepts Corporation. **Survey of Consumer Attitudes And Awareness of the Metric Conversion of Distilled Spirits Containers.** Reston, Virginia: Applied Concepts Corporation (P.O. Box 2760, Reston, VA 22090), December, 1981.

Examines a completed private sector conversion to the metric system, in the light of the U.S. Metric Board's planning guidelines and procedures. Also contains the results of a consumer survey that assesses current attitudes, awareness, and behavior as they relate to information needs of the customer in making marketplace purchase decisions.

Benedict, John T. **Metrication For The Manager.** Washington, D.C.: American National Metric Council, 1977.

Serves as a prime reference source for metrication management. Fills middle management's need for condensed, authoritative information about the metrication process.

Cooper, Edith Fairman. **Social and Economic Implications of U.S. Conversion To The Metric System of Weights and Measures: Spectrum of Current Opinions.** Washington, D.C.: Congressional Research Service, February 12, 1979.

Presents a compilation of differing opinions concerning the social and economic implications of the Nation's conversion to the metric system of weights and measures.

Cushen, W. Edward. **Metric Use In The Machine Tool Industry–A Status Report and a Test of Assessment Methodology.** Washington, D.C.: J.F. Coates, Inc. (3738 Kanawha Street, N.W., Washington, D.C. 20014), April 1982.

An exploratory assessment of the status of metrication in the U.S. machine tool industry. Draws directly on the experience of industry practitioners and on data from many public and private sources. Emphasizes the present and potential interactions of metrication with other issues and problems facing the machine tool industry.

Goldman, David T. **SI: Prognosis For The Future.** Washington, D.C.: Journal of College Science Teaching, February 1981.

Discusses the International System of Units (Système International), the version of the modernized metric system that is the internationally agreed upon practical system of units of measurement. In addition, it presents a survey of what SI is, how it came about, and how it is likely to develop in the future.

Interagency Committee on Metric Policy. **Federal Metric Information Referral Directory.** Washington, D.C., December 1981.

Lists Federal agency personnel knowledgeable about the status within preeminent areas of Federal responsibility.

International Brotherhood of Electrical Workers. **Realities of Metrication – A Report.** Washington, D.C., 1977.

Traces the history of labor's involvement with metrication and examines the major arguments for conversion, the impact of conversion in the U.S., and the role of labor and the Federal Government.

King, Lisa L. **U.S. Metric Board 1979 Survey of Selected Large U.S. Firms and Industries–Final Report.** Rockville, Maryland: King Research, Inc. (6000 Executive Boulevard, Rockville, Maryland 20852), May 1980.

Reports on the status and projections of metrication among large U.S. firms and industries and provides both government and industry with informaton regarding voluntary conversion to the metric system.

Middlesex Research Center, Inc. **Effects on Safety in the Workplace for Selected Occupations.** Washington, D.C.: Middlesex Research Center, Inc. (3413½ M Street, N.W., Washington, D.C. 20007), April, 1982.

Addresses the need for a detailed analysis of safety issues related to metric conversion. Identifies those occupational tasks that, when subjected to measurement change, would most likely create worker safety hazards and public safety hazards.

National Bureau of Standards. **A Metric America: A Decision Whose Time Has Come.** Washington, D.C.: U.S. Department of Commerce, 1971.

Evaluates the impact of increasing worldwide use of the metric system on the United States and considers alternatives for national

policy. Twelve supporting volumes provide additional details.

Science Management Corporation. **Federal Procurement Metrication: Appropriateness and Methods.** Science Management Corporation, 1120 Connecticut Avenue, N.W., Suite 200, Washington, D.C. 20036, July, 1982.

Examines the relationships between government procurement, agency operations, and private sector metrication initiatives in order to develop an understanding of and strategies for a metric procurement consistent with supplier, purchaser, and user requirements as well as national metric policy.

United States General Accounting Office. **Getting A Better Understanding of the Metric System – Implications If Adopted by the United States – Executive Summary.** Washington, D.C., October, 1978.

Analyzes the still unresolved question of whether the Nation's measurement system should be changed. Provides the Congress, the Administration, the U.S. Metric Board, and all Americans with a better understanding of the issues involved.

United States General Accounting Office. **Getting A Better Understanding of the Metric System – Implications If Adopted By the United States.** Washington, D.C., October, 1978.

Discusses the implications if the U.S. converts to the metric system of weights and measures in addition to discussing the conversion experiences of other countries. Presents the results of 1,400 questionnaries mailed to small businesses, the 500 largest industrial corporations, all State governments, and State educational agencies, 400 associations in the building and construction industry; discussing consumer views; reviews relevant legislation and available documents on metrication; and includes discussions with officials of Canada's metric commission, the United Kingdom's metrication board, and with several British and Canadian industry representatives.

United States Metric Board. **Five Years After the Metric Conversion Act Where Do We Stand? Survey of Large U.S. Manufacturing and Mining Firms.** (the **Fortune** Magazine 1000) **Executive Summary.** Arlington, VA: U.S. Metric Board, December, 1980.

Presents the results of this survey which addresses the number of companies producing metric products and providing metric services, the proportion of total sales (foreign and domestic) that are metric products, the extent of planning underway for the use of the metric system in industry, inhibitions affecting metrication, and expectations for the future.

U.S. Metric Board. **1979 Annual Report.** Washington, D.C., 1980.

Reports on the annual activities of the United States Metric Board. Includes a status report on the extent of metric usage and projections for future conversion activity.

U.S. Metric Board. **1980 Annual Report.** Washington, D.C., 1981.

Describes the actions taken by the U.S. Metric Board in support of the Congressional instructions set forth in the Metric Conversion Act of 1975. In addition, provides a status report on the progress of increasing voluntary metric usage.

U.S. Metric Board. **U.S. Metric Board Research Overview and Analysis.** Arlington, Virginia, April 1982.

Presents the findings as well as the conclusion of the agency's research efforts and discusses recommendations for a national assessment of metrication.

U.S. Metric Board. **U.S. Metric Board Summary Report.** Arlington, Virginia, July 1982.

The agency's final summary report which presents its activities and accomplishments over the last five years and provides recommendations to Congress and the President.

Ehkin, Lawrence P.; Thorne, Betty J.; and Keaton, Paul N. **Metric Conversion: Where We Are and Where We're Going.** Society for Advancement of Management, Spring 1980.

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VI. International Issues

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Conversion Tables

Approximate Conversions to Metric Measures

Customary Symbol	When You Know	Multiply by	To Find	Metric Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric ton	t
		VOLUME		
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in^3	cubic inches	16	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	degrees Fahrenheit	5/9 (after subtracting 32)	degrees Celsius	°C

Metric Measures to Approximate Conversions

Metric Symbol	When You Know	Multiply by	To Find	Customary Symbol
		LENGTH		
mm	milliliters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares ($10,000m^2$)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric ton (1000 kg)	1.1	short tons	
		VOLUME		
mL	milliliters	0.03	fluid ounces	fl oz
mL	milliliters	0.06	cubic inches	in^3
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	degrees Celsius	9/5 (then add 32)	degrees Fahrenheit	°F

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IMPORTANT NOTE

There is some confusion about the role of the U.S. Metric Board and the national policy on metric conversion.

Congress established the Board to plan and coordinate the voluntary increasing use of the metric system. It is not, however, the role of the Board to promote metric usage.

The Board is an independent Federal agency responsible for conducting public information and education programs and appropriate research, coordination and planning activities.

Metric Conversion in this country is voluntary. When Congress passed the Metric Conversion Act in 1975 it did not make conversion mandatory; nor did it establish a target date or deadline for conversion.

The Board has no compulsory power. It is a public service agency consisting of citizen representatives from all walks of American life. Its 17 members are appointed by the President and confirmed by the Senate. Members are nominated to represent labor, retailing, small business, industry, construction, state and local governments, science, engineering, consumer groups and the public at large.

Please contact us if you have any questions about the role of the Board or the national policy on metric conversion.

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